UNIVERSITY OF SASKATCHEWAN

College of Engineering

G.E. 120.3

Introduction to Engineering II

FINAL EXAMINATION #1

March 3rd, 2003

7:00 PM - 9:00 PM

STUDENT NAME: _____

STUDENT NUMBER: _____

LECTURE SECTION:
- L02   Tu-Th   11:30 – 1:00   Prof. H.C. Wood
- L04   Tu-Th   1:00 – 2:30   Prof. T.G. Crowe
- L06   Tu-Th   2:30 – 4:00   Prof. T.C. Muench

Question 1	/ 10
Question 2	/ 10
Question 3	/ 10
Question 4	/ 10
Question 5	/ 10
Question 6	/ 10
Question 7	/ 10
TOTAL	/ 70

GENERAL INSTRUCTIONS FOR THE QUESTIONS

1) **NO** textbooks, **NO** notes, **NO** assignments, and **NO** laboratory logbooks/reports.

2) **NO calculators allowed**.

3) Neatness counts. Please ensure your paper is readable.

4) Some questions contain special instructions. Please ensure that you read these carefully.

5) Not all questions are of the same difficulty and value. Consider this when allocating time for the solution.

6) *IF A QUESTION PROVES TO BE TOO HARD FOR YOU TO SOLVE, GO ON TO ANOTHER QUESTION! RETURN TO THE TROUBLESOME QUESTION WHEN TIME PERMITS.*

PLEASE NOTE

ALL parts of the examination paper MUST be handed in before leaving.

Please check that your examination paper contains 9 pages TOTAL.

QUESTION #1
MARKS: 10 (2x5)
SHORT ANSWER

1.   Briefly explain why you did not require the construction costs for the floor joists, flooring, ceiling joists and ceiling panels in the Mechanical Engineering lab.

2.   List a technical area in which both electrical engineers and mechanical engineers work.

3.   The optimum baking process in the Agricultural and Bioresource Engineering lab required that you specify what 2 parameters?

4.   What statement did Professor Bugg use to explain the difference between mechanical engineering and civil engineering?

5.   List a technical area in which both civil engineers and agricultural and bioresource engineers work.

QUESTION # 2

MARKS: 10 (4 x 2.5)

Matching: Draw a line from the Question on the left

PLEASE NOTE: The last option given at the bottom for matching is 'None of the Above'

To the Answer on right

1) -4

a)   Given the 3 simultaneous equations below, solve for X2.

2) -2

$X_1 + 2X_2 + X_3 = 3$
$2X_1 + 3X_2 + X_3 = 2$
$X_1 + X_2 + X_3 = 1$

3) $\begin{bmatrix} -7 & -4 & 2 \\ 5 & -1 & 7 \\ -1 & 5 & 4 \end{bmatrix}$

b)   Determine the adjoint of the following matrix

$\begin{bmatrix} 3 & 1 & 2 \\ 2 & 2 & 3 \\ 2 & 3 & 1 \end{bmatrix}$

4) $\begin{bmatrix} -7 & 5 & -1 \\ 4 & -1 & -5 \\ 2 & -7 & 4 \end{bmatrix}$

5) $\begin{bmatrix} -7 & -5 & -1 \\ -4 & -1 & 5 \\ 2 & 7 & 4 \end{bmatrix}$

c)   Given the following matrices A and B, determine $[A][B]^T$

$A = \begin{bmatrix} 2 & -3 & 5 \\ -1 & 2 & 1 \\ 2 & 1 & 3 \end{bmatrix}$ $B = \begin{bmatrix} 2 & 1 & -1 \\ 3 & 2 & 1 \\ 2 & 1 & 1 \end{bmatrix}$

6) $\begin{bmatrix} -4 & 5 & 6 \\ -1 & 2 & 1 \\ 2 & 11 & 2 \end{bmatrix}$

7) $\begin{bmatrix} -4 & 5 & 6 \\ -1 & 2 & 1 \\ 2 & 11 & 8 \end{bmatrix}$

d)   Calculate the Determinant shown

$\begin{vmatrix} 1 & 2 & 1 & 3 \\ 2 & 3 & 3 & 1 \\ 1 & 2 & 1 & 2 \\ 1 & 3 & 2 & 1 \end{vmatrix}$

8) $\begin{bmatrix} 5 & 1 & 0 \\ 6 & 4 & 4 \\ 13 & 7 & 2 \end{bmatrix}$

9) 4

10) 2

11) None   of   the   above

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QUESTION #3

MARKS: 10 (3 + 1 + 2 + 2 + 2)

SHORT ANSWER

1. **Set up** the 3 matrices in the form [A][x]=[B], such that they could be solved using the Adjoint Method. **DO NOT SOLVE.** Show the elements of each.

   $2x_1 + 7x_2 + 3x_3 = 15$
   $-x_3 + 6x_1 + 2x_2 = 1$
   $9x_2 + 2x_3 + 8x_1 = 16$
   $9x_3 + 13x_2 + 4x_1 = 19$

2. Solve:

$$\begin{vmatrix} 7 & 1 & 4 & 2 \\ 14 & 2 & 8 & 4 \\ 9 & 6 & 5 & 1 \\ 11 & 13 & 1 & 9 \end{vmatrix}$$

3. Given the following matrices:

$$[A]=\begin{bmatrix} 5 & 1 & 3 \\ 2 & 4 & 7 \end{bmatrix} \qquad [B]=\begin{bmatrix} 3 & 2 & 7 \\ 4 & 0 & 2 \end{bmatrix} \qquad [C]=\begin{bmatrix} 3 & 4 \\ 9 & 2 \\ 6 & 7 \end{bmatrix}$$

   Determine [D], Where [D] = ([A]+[B])^T − [A]^T − [B]^T + [C]

4. Given the following 3 equations, and the solutions to the Determinants as shown, solve for the variables X$_1$, X$_2$, and X$_3$

$$\begin{aligned} 4X_1 - 8X_2 + 10X_3 &= 72 \\ -6X_1 + 10X_2 + 14X_3 &= 14 \\ 10X_1 + 6X_2 - 16X_3 &= -62 \end{aligned}$$

$$\begin{vmatrix} 4 & 72 & 10 \\ -6 & 14 & 14 \\ 10 & -62 & -16 \end{vmatrix}=8064 \quad \begin{vmatrix} 4 & -8 & 10 \\ -6 & 10 & 14 \\ 10 & 6 & -16 \end{vmatrix}=-2688 \quad \begin{vmatrix} 4 & -8 & 72 \\ -6 & 10 & 14 \\ 10 & 6 & -62 \end{vmatrix}=-10752 \quad \begin{vmatrix} 72 & -8 & 10 \\ 14 & 10 & 14 \\ -62 & 6 & -16 \end{vmatrix}=-5376$$

5. Find the determinant of C. Note that a simple row or column manipulation may significantly simplify the problem.

$$C=\begin{bmatrix} 1 & 0 & 0 & 3 \\ 2 & 7 & 0 & 6 \\ 0 & 6 & 3 & 0 \\ 7 & 3 & 1 & -5 \end{bmatrix}$$

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QUESTION #4

MARKS: 10 (2x5)

SHORT ANSWER / Multiple Choice

For the following questions, refer to the matrices shown here.

$$\text{Let}\quad A = \begin{bmatrix} 2 \\ 5 \\ \delta \\ -2 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 9 & 0 \\ 2 & 8 & -\beta \\ 2 & -5 & 3 \\ -3 & 6 & 3-\alpha \end{bmatrix} \quad C = \begin{bmatrix} \delta & -2 & -2 & 5 \end{bmatrix}$$

There is one and only one correct answer. Circle the number of the correct answer

1.   Referring to B and A above,

   1) BA can not be calculated
   2) BA results in a 4x1 matrix
   3) B is symmetric
   4) None of the above is correct
   5) Two of the first three statements are correct
   6) All of the first 3 statements are correct

2.   Let D=A^{T}B

   1) The rank of D is 1x4
   2) The trace of D is –22
   3) Element $d_{13} = -5\beta + 3\delta + 2\alpha - 6$
   4) None of the above is correct
   5) Two of the first three statements are correct
   6) All of the first 3 statements are correct

3.   Based on matrices A and C above:

   1) The matrix that results from AC has a single element.
   2) CA=[0]
   3) A+C can not be calculated
   4) None of the above is correct
   5) Two of the first three statements are correct
   6) All of the first 3 statements are correct

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4.   Based on matrices A and C above:

1) $C + A^T = [2+\delta \quad 3 \quad \delta - 2 \quad 3]$

2) $C + A^T = \begin{bmatrix} 2+\delta \\ 3 \\ \delta - 2 \\ 3 \end{bmatrix}$

3) $AC = \begin{bmatrix} 2\delta & -4 & -4 & 10 \\ 5\delta & -10 & -10 & 25 \\ \delta^2 & -2\delta & -2\delta & -10 \\ -2\delta & 4 & 4 & -10 \end{bmatrix}$

4) None of the above is correct
5) Two of the first three statements are correct
6) All of the first 3 statements are correct

5.   Which of the following statements are correct

1) The determinant of an identity matrix that is of order 256x256 is 1
2) The determinant of a matrix is –4. You then complete 2 elementary row operations, $R'_3 = R_3 + 2R_2$ and $R'_2 = R_2 - 7R_1$. The determinant of the new matrix is –4.
3) If I is an identity matrix with appropriate order and B is the matrix above, IB equals BI
4) None of the above is correct.
5) Two of the first three statements are correct.
6) All of the first 3 statements are correct.

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QUESTION #5

MARKS: 10

What is the relationship between α and β in the matrix below if the determinant is equal to zero?

$$\begin{bmatrix} 1 & 1 & a \\ 1 & 1 & b \\ a & b & 1 \end{bmatrix}$$

QUESTION #5

Student Name: _____   Student Number: _____

QUESTION #6
MARKS: 10 (5 + 2 +3)

a) Solve the following set of simultaneous equations using the adjoint matrix method.

b) Verify your solution.

c) Write the complete MATLAB instructions to solve this set of equations.

$$a + 2b + 3c = 2$$

$$3b + c + 2a = 7$$

$$2c + a + 2b = 3$$

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QUESTION #7

MARKS: 10

USE GAUSS ELIMINATION TO SOLVE THE FOLLOWING.
Immediately after graduating, a Commerce graduate is struggling to find employment. Eventually, he gets a job counting cars at a particular intersection. For a short period on a quiet Sunday morning, he notes that in every black car there are 3 children and 1 woman. Every red truck has a man and a woman (0 children), and taxi cabs have one each of man, woman and child. In total, 36 people went through the intersection, including 20 children and 5 men.
The Commerce graduate also noted that half of the black cars and taxi cabs and one-third of the red trucks failed to use their signal lights. How many vehicles failed to use their signal lights?